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(54) **Electrostatic discharge noise suppression method and system for electronic device.**

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EP-A- 0 300 872
JEE JOURNAL OF ELECTRONIC ENGINEERING. vol. 18, no. 174, June 1981,TOKYO JP pages 44 - 49; YUICHI MURAKAMI: 'EMC in Electronic Systems Growing inSophistication'

(56) References cited :
HENRY W. OTT 'noise reduction techniques in electronic systems' & SONS ,NEW YORK
SIEMENS ZEITSCHRIFT. vol. 51, no. 8, 1977, ERLANGENDE pages 620 - 624; V. SEILER: 'Schnittstellenfilter für Daten-undSignalleitungen'

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Description

The invention is directed to a noise suppression method and circuit for an electronic device for suppressing electrostatic discharge (ESD) noise pulses which affect the electronic device and data buses connected to these devices.

Most of the problems encountered with ESD are caused by electrostatically charged human bodies touching the electronic devices, either its chassis or external cables, causing discharge currents to flow towards ground. For example, hard to solve problems occur when tape cassettes, cartridges or diskettes are inserted into data storage devices. These devices are usually mounted as subassemblies in the computer chassis.

During a discharge event, tens of amperes can flow in less than a nanosecond. An electromagnetic wave will propagate towards ground on the chassis and the cables leaving the device. Due to the very high frequencies involved, much of the prior art ESD problem solving has been directed towards proper shielding and grounding of the electronic devices. The coupling mechanisms can be divided into four parts: Direct conduction, secondary arcing, electric field, and magnetic field couplings. To solve the problems associated with electric field coupling to the circuits, it is recommended not to float the signal grounds with respect to the chassis ground or not to provide an external ground connection independent of the chassis ground to the electronic devices. A multiple grounding scheme is therefore often used for the devices inside the chassis. To solve the problems with magnetic coupling, shielding is usually recommended. However, for cables used for data buses, problems arise due to this multiple grounding scheme. When the signal ground of, say, both ends of a data bus cable is connected to the chassis, a ground loop is formed. Noise currents can then flow if the chassis potential is different at the two ends or if voltages are induced in the loop due to magnetic coupling. For a discussion of the prior art, see Ott, H.W., "Noise Reduction Techniques in Electronic Systems", 2nd ed. John Wiley & Sons, New York, 1988; and Hewlett Packard Course No. HP 11949A; "Designing for Electromagnetic Compatibility", Application Support Division, Mountain View, CA, U.S.A., 1989.

It is known in the art that ESD protection of the data buses can be obtained by using ferrite tubes or clamped ferrite pieces around the signal cables. See Murakami, Yuichi, JEE Journal of Electronic Engineering, Vol. 18, No. 174, June 1981, page 49, Figure 8; and Hewlett Packard Course No. HP 11949A, supra.

The function of these ferrite components is then as a common-mode inductor.

The problem with these data bus protection schemes can be divided into two parts. First, due to the leakage inductance of the common mode inductors available, the high frequency components of the differential signal currents may also be attenuated if the common mode impedance is too high. It is therefore very difficult to obtain a good protection against noise. Second, the data buses typically consist of as many as 50 signal and ground wires and a common mode inductor for all these signal lines becomes very expensive. An alternative consists of using ferrite clamps around the cables, but even those tend to be expensive parts.

It can be also mentioned here that other types of usage exists for common-mode inductors. They can be used to prevent conducted radiated electromagnetic noise from leaving the devices via cables. See, for example, Siemens Aktiengesellschaft, "EMC EMI Suppression Components, Filters", Data Book 1987/88. For signal lines, the leakage inductance can also be utilized to limit the bandwidths of the differential signal waveforms transmitted on the cables.

It is an object of the invention to provide a noise suppression system for an electronic device such that electrostatic noise discharges which occur in pulse-like fashion and only sporadically, but which can create considerable noise currents, can be reliably controlled in a simple and cost-beneficial way.

In laboratory investigations I have conducted, I have found that a strong, mainly inductive, electromagnetic coupling exists between the chassis ground and the DC power supplies usually contained within the electronic systems. The reason is that the power supplies are always located close to where the ground wire of the AC mains cable is connected to the chassis and that the leakage inductance of the inductors or transformers found in the power supplies provides the coupling path. The coupled noise will be very strong because the ESD currents concentrate here before leaving the chassis via the mains cable.

According to my invention, I have recognized that the relevant ESD problems originate from the coupling to the DC power supplies, and that multiple ground loops are formed between the chassis, via the coupling to the DC power wires, to the local ground on the electronic devices where disturbances can take place, further via the data bus where the signals are disturbed, and back again via the bus and the ground or chassis connections of the other devices connected to the same signal bus. To avoid electric field coupling or secondary arcing, the signal ground or data bus ground is connected to chassis ground. The invention system for ESD protection disclosed and claimed herein therefore comprises breaking the high-frequency ground loops by inserting common mode inductors which operate without saturating their cores and by locating them where they can be most effective: in the DC power supplies themselves, in the DC power connections, or just behind the DC connector in the electronic devices. Measurements have shown that the system of this invention provides great improvements compared with the bus-protection method known in the prior art. Saturation of the cores of the common mode inductors is prevented in a preferred way by equalizing supply and return currents in the common mode inductors and by preventing DC ground currents from flowing in a chassis between the power supply and the electronic device.

Figure 1 is a circuit diagram showing and explaining the electrostatic discharge noise suppression method and system in accordance with a first embodiment of my invention;

Figure 2 shows an electrostatic discharge noise suppression coil assembly used in the first embodiment system of Figure 1;

Figure 3 is a circuit diagram of an electrostatic discharge noise suppression method and system in accordance with a second embodiment of my invention;

Figure 4 is a diagram showing an electrostatic discharge noise suppression coil assembly as used in the second embodiment of Figure 3;

Figure 5 is a circuit diagram showing an electrostatic discharge noise suppression method and system according to a third embodiment;

Figure 6 is a diagram showing an electrostatic discharge noise suppression coil assembly according to the third embodiment of Figure 5;

Figure 7 is a circuit diagram showing the embodiment of Figure 5 but expanded to show application of the inventive method and system wherein the electronic device comprises electronic computer modules; and

Figure 8 is a typical pulse diagram showing a measured electrostatic discharge noise oscillation on one line of a data bus in Figure 7 when the invention is not provided.

Figure 1 shows a first embodiment of the electrostatic discharge noise suppression method and system according to my invention. 10 is a DC power supply contained within what may be a common chassis 1, shown with ground symbols 21 and 22 connecting thereto, indicating grounding to such a common chassis. Of course, if two separate chassis such as 101 and 102 shown in dashed lines are provided, then typically a connecting ground wire 100 shown with dashed lines would be provided between them. Ground wire 100 might be dispensed with, however. The power unit itself is shown with the symbol 14. Within 14 one typically finds linear or switching transformers. The positive output from 14 connects via lead 9 to the power input pin 19 of the electronic device 13. The DC current goes via the load not shown to a signal ground "SGND", of device 13 and out via 20. The signal ground SGND may be different than chassis ground and could, for example, be foil on a printed circuit board mounted in the chassis 1. If the chassis ground connection 22 is not connected to 8, the DC current returns from pin 20 via 8 to the negative side of 14. In between 10 and 13 is inserted a common mode inductor 15 with windings 16 and 17 wound with equal number of turns, in the same direction, on a common core 18. Two connector assemblies are shown as 11 and 12, so that 15 can easily be inserted between 10 and 13. The chassis grounding 21 of the electronic device 13 is usually done via multiple ground wires in a ribbon data or signal cable going to other devices similar to 13. This will be shown in detail in Figure 7.

To allow for an optimization of the common mode inductor 15 with respect to impedance, self resonant frequency, size and cost, currents "I" and "Ir" should be equal. 8 should therefore not be connected to ground at 22. If 8 is connected to 22, a ground current "Ig" as shown in Figure 1 with dashed lines will be subtracted from "Ir", so that IR < I, and there is a risk of saturating the core 18. If 18 is saturated, the device will not present the intended common mode impedance to the wave front. The power supplies available on the market usually come with the option for a ground connection 22 or not for the return wires. This option is illustrated by switch 70 shown in an open position. In the case one is forced to use a grounded return, say, if it is already designed into the system, a resistor "Y" should be introduced between the signal ground "SGND" (such as on the foil of a PC board) and the chassis ground connection 21, or between the DC return line 20 at the device 13, if it does not have a separate signal ground, and the chassis ground at 21. If this resistor has a small value of the order of a few ohms, nearly all the return currents will flow back to 8 and the core will not be saturated because the typical DC resistance of windings 16 and 17 is in the range from 0.01 ohms and upwards.

The AC mains ground connection where the electrostatic discharge noise current flows is located close to chassis connection 22. The rapidly changing, very strong magnetic field will induce a high voltage pulse in the loop consisting of 22, wires 9 and 8 in parallel, via 15, to 20 and "SGND" and also via 19 and the decoupling capacitor "X" to "SGND" and further to the chassis ground connection 21 and back again to the first chassis connection 22. The common mode inductor 15 presents a high impedance to the wave front and prevents large noise currents from flowing in the said loop.

If all devices are contained within the same chassis, i.e. if 22 and 21 are different physically located connections on the same common chassis such as shown by the solid line box, the common mode wave can be considered to be a local one. However, 15 is also so designed that it presents a high impedance to the low frequency oscillations, typically in the lower MHz range, which takes place after the discharge excitation. These oscillations can be explained with the aid of a simple model: the ground wire in the mains cable is modeled as an inductance in series with a resistor and this circuit is in parallel with the capacitance from chassis to the external ground, simulating the charges on the chassis. Thus, the system will exhibit damped oscillations with reference to an external ground when excited by the discharge pulse. If the external ground connects via, say, printer cables or local area network cables to the internal ground point 21, common mode waves and oscillatory currents may be set up on these wires. The inventive method and system disclosed herein for electrostatic discharge noise protection is especially well suited for suppression of these oscillatory currents in the lower MHz range because the self resonant frequency of the common mode inductor can easily be placed in this frequeny range where the oscillations occur.

A second loop exists in Figure 1, namely the differential loop where the DC current is flowing when the return wire 8 is not grounded to 22: from 9 via 16 to 19, further via the decoupling capacitor "X" to "SGND" and 20 and back to the power supply 14 via 17 and 8. During the discharge event, a differential voltage is also induced in this loop. Usually, this voltage is much less than the common mode voltage, since the differential loop is much smaller than the common mode loop. The leakage inductance of coils 16 and 17 together with the decoupling capacitor "X" provide attenuation for this differential voltage. The magnetic coupling to this last mentioned loop can also be minimized by twisting the wires 8 and 9 together.

Figure 2 schematically shows the electrostatic discharge noise suppression coil used in Figure 1. The common mode inductor 15 is inserted between the power supply unit 10 and the electronic device 13. These units are contained within one common chassis structure shown in solid lines. It is understood that 15 can also either be implemented as part of 10 or as part of 13. If it is part of power supply 10, great care in the actual location of the common mode inductor within 10 must be taken to avoid magnetic coupling from the electrostatic discharge chassis currents and to the leakage inductance of 15. Care must also be taken to ensure a very low capacitive coupling.

Figure 2 shows windings 16 and 17 placed on each half of a ring-shaped core or toroid. In this case a coupling factor of typically 0.8 can be obtained between windings 16 and 17, providing enough leakage inductance for effective attenuation of the differential mode. If greater emphasis must be put on the attenuation of the common mode, one should also consider making the coils 16 and 17 part of one bifilar winding. Then it may be possible to obtain an even tighter coupling between 16 and 17. Further, special care should be placed on providing a low-capacitance path between the input and output sides of 15 to enhance the high-frequency performance of the component 18. Other types of cores may as well be used to make the common mode inductor.

Figure 3 schematically illustrates a second embodiment of the electrostatic discharge noise suppression method and system according to my invention. 23 is a power supply module typically found in many computer systems. It contains a +5 volt supply 35 with output 39 and return 40, and a +12 volt supply 36 with output 42 and return 41. Within 23, returns 40 and 41 are not to be connected together in the embodiment, but might be connected together as shown by dashed line 4 by some existing power supplies. As was the case for Figure 1, the return wires 40 and 41 should not be connected to the chassis as shown by the open switch 5, but in some cases such a connection 38 already exists. This would be represented by switch 5 being closed. It may have been done to reduce the electromagnetic radiation from the power supply module 23. Between the power module 23 and the electronic device 26 are inserted two common mode inductors 27 and 28, consisting of windings 30/31 on the core 29 and windings 33/34 on the core 32, respectively. Connector assemblies are shown as 24 and 25, but as for the first embodiment, the common mode inductors may as well be physically located at the power supply side 23 if great care is taken or at the electronic device side 26 if this is more convenient. Internally in the electronic module 26 returns "I1r" and I2r" must nearly always be connected together: the returns are connected to the signal ground, "SGND", in module 26. As described for the embodiment of Figure 1, a chassis connection 37 must be provided for the signal ground "SGND" at module 26, either directly as shown or via the multiple ground wires of a data or signal cable connecting to subassemblies similar to 26. Decoupling capacitors "X" and "Z" are shown within the electronic device 26, to ease the understanding of the common mode loops. The actual DC loads are not shown. An optional low-value resistor "Y" is shown for the case when the returns of the power units 35 and 36 are connected to the chassis 38 (represented by switch 5 closed). The purpose of this resistor is the same as in the first embodiment: to reduce the DC current "Ig" so that I1r=I2r, with good approximation.

As for the first embodiment, it is understood that all units may be contained within one chassis, shown with solid line 7 and having ground symbols with numerals 37 and 38. Alternatively, separate chassis 201, 202 with ground wire 200 may be provided.

The operation and constraints of the second embodiment are easily understood as soon as the first embodiment is understood and will not be described in greater detail here, except for an important comment in the case where the return wires 40 and 41 are connected together at the power supply module 23, as shown by dotted line 4 in the drawing. This may well be the case for many power supplies already designed into the system. In this case great care must be taken in making the DC resistances of windings 31 and 33 equal. Since this is very difficult to obtain because 27 and 28 are selected at random from a large production batch or even picked from different production batches of common mode inductors, the currents "I1r" and "I2r" will generally be different and be divided between windings 31 and 33 in accordance with the actual conductance of these windings. If the embodiment of Figure 3 is used, one must therefore be sure that there is no DC connection between 40 and 41 and the dashed line conductor 4 should not be present. When this separation is taken care of, the two common mode inductors may be independently optimized with respect to the impedance levels and the DC resistances, although a full degree of freedom in the design is not present due to the placement of the self resonant frequencies of the two inductors.

Figure 4 shows the electrostatic discharge noise suppression coils 27 and 28 used in the embodiment of Figure 3. 29 and 32 are the ferrite cores, onto which windings 30/31 and 33/34 are wound, respectively, in such a way that the magnetic fields set up by currents I1/I1r and I2/I2r will cancel in the respective cores, but if and only if the I1=I1r and I2=I2r. It is understood that the components 27 and 28 can equally well be located within 23 if great care is taken in doing so, or 27 and 28 can be located in the device 26.

Figure 5 is a schematic diagram showing the electrostatic discharge noise suppression method and system according to a third and preferred embodiment for multiple supplies. It is an improvement compared with the second embodiment because, unlike the embodiment of Figure 3, the return wires 56 and 57 can freely be connected together as shown by solid line 3. If the DC chassis current Ig is zero, i.e. if the chassis connection 54 is not connected to the return wires 56 and 57, I1+I2 = I1r+I2r, the core 48 will not be saturated with DC magnetic fields or not be close to saturation and a maximum advantage of the invention is obtained. If the chassis connection 54 of the return wires 56 and 57 at the power supply side must be maintained, one can minimize the DC chassis current Ig by introducing a low-value resistance "Y" between the signal ground "SGND" and the chassis point 53, as explained for the first embodiment. It is understood that the units 43, 44, 47, 45, 46 as well as the wires 55, 56, 57 and 58 shown are all contained within the same chassis 6, shown with ground symbols numbered 53 and 54 attached. Alternatively, separate chassis 301 and 302 with a connecting ground wire 300 may be provided. It is also understood that connections to external grounds via, for example, printer cables or local area network cables can also take place. Such connections can then form external ground loops with the ground cable of the mains supply which for safety reasons must connect to the chassis, usually at point 54.

In Figure 5, 43 is the power supply module, comprising two power units 59 and 60, delivering +5 volt and +12 volt, respectively. It is understood that other voltage levels can be used. Also, multiple power units can be used if the magnetic ferrite core 48 is supplied with multiple sets of windings. The wires 55 and 56 from the +5 volt supply unit 59 go via a connector 44 through the windings 49 and 50, respectively, on the core 48 to another connector 45 and to the electronic device 46. Wire 55 carries current I1 which returns to the signal ground "SGND". Similarly, wires 58 and 57 connect via 44 to the windings 52 and 51, respectively, on the core 48 and go via connector 45 to the electronic device 46. Wire 58 carries current I2 which goes via a load not shown to the signal ground "SGND". The DC return currents I1r and I2r will now divide between windings 50 and 51 in accordance with their DC conductance, except for a small current Ig which, in some practical implementations may be allowed to flow in the low-valued resistor "Y". However, since all the four windings 49, 50, 51 and 52 are wound in the same direction on the core 48, current I1r need not be equal to I1, and I2r need not be equal to I2, if I1+I2=I1r+I2r, assuming that Ig is zero or is made so small that it can be neglected.

As explained for the first embodiment, the purpose of the common mode inductor 47 is, by its high level of common mode impedance for high frequencies, to prevent the flow of both chassis-internal ground currents and external ground currents released during the electrostatic discharge event. 47 will be very effective both for the front of the discharge waveform and for the oscillatory waveform of the external ground currents, usually in the lower MHz range, as explained for the first embodiment. Usually, the wires 55, 56, 57 and 58 are twisted together, and one can consider one main chassis-internal ground loop starting at the power supply side chassis ground point 54 where the strongest magnetic coupling to the loop takes place. The loop then consists of a parallel connection of the +5 volt path and the +12 volt path: A): 59 in series with 55/56 and B): 60 in series with 57/58, going on all four wires 55, 56, 57 and 58 to the common mode inductor 47, further going via both return wires and the capacitors "X" and "Z" to the signal ground "SGND". Further, the loop goes to the other chassis connection 53, optionally through the low-value resistor "Y", which is so small that it can not prevent the noise currents from flowing, and back via the chassis to the connection 54 at the power supply side. The external ground loop can also be considered to start at the point 54 where the strongest magnetic coupling is, follow the above mentioned loop to the chassis ground point 53, go out of the chassis via external signal cables connected to 53 and further to external ground connections, typically found at the mains ground connections of other mains-powered equipment, say a display monitor or a printer, and finally closing the loop via the mains ground to the starting chassis point 54. Additionally, minor differential loops exists within the embodiment shown in Figure 5. For these differential voltages, the operation of the circuit is similar to what was found for the first embodiment and will not be described here.

Figure 6 is a diagram showing an electrostatic discharge noise suppression coil 47 used in the third embodiment of Figure 5. It is assumed that both the power supply 43, the wires 55, 56, 57 and 58, the common mode inductor 47 and the electronic device 46 are contained within the same chassis 6. The currents from one power unit, I1 and I1r, both go in a pair of windings 49 and 50. The currents from the other power unit, I2 and I2r, go in the other pair of windings 51 and 52. These winding pairs can typically be made of bifilar windings to improve the impedance balance for common mode waves which follow the wires 55/56 or 57/58. Currents I1 and I2 can also be carried by the pair 55/56 and currents I1r and I2r by pair 57/58. Other winding schemes also exist.

Figure 7 is a schematic diagram illustrating in greater detail an application of my electrostatic discharge noise suppression method and system according to the third embodiment of Figures 5 and 6, wherein the electronic device comprises computer system modules such as 63, 64 and 65. However, the number of modules may be greater than three as indicated in the figure. Only one set of output DC voltages from the power supply module 43 is shown, supplying all modules 63, 64, and 65. Often, more outputs are provided, each output supplying typically two electronic modules. In the drawing, the one four-wire common mode inductor 47 shown in Figures 5 and 6 is contained within the power module 43. By doing so, the electrostatic discharge noise conducted by the DC wires is stopped at the location where it originates. In this case, it is possible to protect multiple subassemblies 63, 64 and 65 which do not have the built-in two- or four-wire common mode protection for electrostatic discharge. In Figure 7, the chassis which encloses both the power module 43, the electronic devices 63, 64 and 65, or more, and the data bus 67, is shown as 46. Internally in the electronic devices 69, 70 and 71, decoupling capacitors are shown as "X1", "X2", "X3", "Z1", "Z2", and "Z3". These have been indicated to show that the electrostatic discharge common mode current path includes these capacitors, as well as the return wires, before the noise currents go to the local signal grounds shown as 53a, 53b and 53c. These signal grounds are normally the same as the ground connected to the data bus 67/68. Therefore, the data bus signal grounds have the corresponding numerals. The common mode noise path further goes via the data bus ground to the chassis point 53, where an optional resistor "Y" can be inserted, as previously explained if the power supply is not floating as would be represented by switch 71 being closed. It is also indicated, by 80, that the data bus can extend to external devices. The discharge noise path will then also include an external ground loop, and oscillatory common mode voltages (see Figure 8) are set up. The inventive method and system is especially well suited to attenuate these low-MHz oscillations. Further, the modules themselves are connected to the chassis at points 73, 74, and 75. The internal leakage DC current is indicated with "Ig". This should ideally be kept to zero or minimized by the resistor "Y".

In a variation of the Figure 7 embodiment, a distributed electrostatic discharge protection scheme may be provided by removing the common mode inductor(s) 47 from the power supply unit 43 and including common mode inductors in each of the electronic devices 63, 64 and 65 or more. The advantage of this approach is that each common mode inductor can be optimized for the DC current drawn by each of the modules 63, 64 and 65 or more, thus providing the highest possible impedance in the sub-loop where it is located. In accordance with this scheme, it is understood that the invention includes the use of four-wire or two-wire common mode inductors in module 63 when it consists of a tape cartridge streamer for data storage, as indicated. The invention also includes the use of such common mode inductors in other data storage peripheral devices, say, if module 64 is a hard disk and 65 is a diskette drive. The invention is equally well valid if the electronic device module is any other subsystem, such as, for example, an optical storage device.

Figure 8 shows a noise waveform measured on one line of a data bus like that shown in Figure 7, but without the protection of the invention. Discharge in an external common mode loop was simulated measured. The initial pulse has a peak of -4 volt, then the low-MHz oscillation follows. After insertion of a four-wire common mode inductor according to the invention, the oscillatory waveform was totally eliminated, and the negative peak was reduced to -1 volt.

Claims

1. An electrostatic discharge noise suppression system, comprising:
an electronic device (13, 26, 46) and a power supply (10, 23, 43) for the electronic device;
chassis means (1; 101, 102; 201, 202; 6; 301, 302) for receiving the power supply (10, 23, 43) and the electronic device (13, 26, 46) and for providing chassis ground (21, 22; 37, 38);
the power supply (10, 23, 43) being located at one portion of the chassis means (1; 101; 202) and having a DC voltage output (9; 39) of a first polarity and a DC voltage return (8; 40) of an opposite second polarity;
the electronic device (13, 26, 46) being located at another portion of the chassis means (1; 102;

201) and having at least one DC voltage input (19; 55; 58) of said first polarity and at least one DC voltage return (20; 56; 57) of said opposite second polarity; and
common mode inductor means (15; 27; 47) for suppressing electrostatic discharge noise having at least one common core (18; 29; 48);
characterized in that said common mode inductor means (15; 27, 28; 47) has first and second windings (16, 17; 30, 31) on each common core (18; 29) the first winding (16; 30) connecting the power supply DC voltage output to the electronic device DC voltage input and the second winding (17; 31) connecting the power supply DC voltage return to the electronic device DC voltage return, and that said system further comprise means for preventing saturation of said common core as a result of a DC supply current (I) flowing from the power supply (10; 23) to the electronic device (13; 26) through the first winding (16; 30) and a DC return current (Ir) flowing from the electronic device (13; 26) back to the power supply (10; 23) through the second winding (17; 31).

2. A system according to claim 1 wherein said means for preventing saturation comprises designing said common core (18; 29) such that any difference between magnitudes of said DC supply current (I) and DC return current (Ir) does not cause saturation thereof.

3. A system according to claim 1 wherein said means for preventing saturation comprises means for making the supply current (I) and the return current (Ir) to be substantially the same so that a relatively small common core (18; 29) can be used without saturation.

4. A system according to claim 3 wherein said means for making the currents (I, Ir) substantially the same comprises means (70, Y; 5) for preventing a ground return current from flowing wire chassis ground (21, 22; 37, 38) from said electronic device (13; 26) to said power supply (10; 23) so that all of the supply current returns through the second winding (17; 31) as said return current (Ir).

5. A system according to claim 4 wherein said means (70; 5) for preventing a ground return current comprises not electrically connecting that power supply opposite polarity DC voltage return to chassis ground (22) at the location of the power supply (10).

6. A system according to claim 5 wherein said DC voltage return at the electronic device (13; 26) is electrically connected to the chassis ground (21; 37) at the location of the electronic device.

7. A system according to claim 4, wherein said means (Y) for preventing a ground return current comprises not directly connecting to chassis ground (21; 37) the DC return of the electronic device (13; 26) at the location of the electronic device.

8. A system according to claim 4 wherein said means (70 Y; 5) for preventing a ground return current comprises the DC returns at either the power supply (10; 23) or the electronic device (13; 26) being not directly connected to chassis ground.

9. A system according to claim 4 wherein said means for preventing a ground return current comprises provision of a resistance (Y) between the DC return (20) at the electronic device (13; 26) and chassis ground (21; 37) at the location of the electronic device, said DC return at the power supply (10; 23) being connected to chassis ground (22; 38) at the location of the power supply, and wherein a magnitude of said resistance (Y) is chosen so as to substantially prevent a ground current (Ig) from flowing which would result in a difference of the supply current (I) and return current (Ir) flowing in the first and second windings (16, 17; 30, 31) which would cause saturation of the common core (18; 29).

10. A system according to claim 1 wherein the electronic device (13; 26) has a decoupling capacitance (X) between said DC voltage input (19) and DC voltage return (20).

11. A system according to claim 1 wherein at said electronic device (13; 26) said DC return (20) is connected to a signal ground (SGND) and said DC return (20) is floated at the location of the power supply (10; 23).

12. A system according to claim 1 wherein said signal ground (SGND) is on a printed circuit board which is part of the electronic device (13; 26).

13. A system according to claim 1 wherein the DC return (20) is connected to chassis ground (21; 37) at the electronic device (13; 26) but is not connected to chassis ground (22; 38) at the location of the power supply (10; 13) so as to make a DC output current (I) from said power supply to said electronic device substantially equal to a return current (Ir) from said electronic device to said power supply on said return so that substantially no ground currents (Ig) flow through the chassis means (1; 101, 102; 201, 202; 6; 301, 302) from

the electronic device chassis ground (21) to the power supply, thus aiding in preventing a saturation of the core (18; 29) of the common mode inductor means (15; 27) caused by unequal DC currents in the two windings (16, 17; 30, 31) of the inductor means.

14. A system according to claim 1 wherein said chassis means comprises a common chassis (1) within which is located both the power supply (10; 23) and the electronic device (13; 26).

15. A system according to claim 1 wherein said chassis means comprises to separate chassis (101, 102; 201, 202), one (101; 202) for the power supply (10; 23) and one (102; 201) for the electronic device (13; 26).

16. A system according to claim 15 wherein an electrical connection means (100; 200) for permitting ground currents to flow from the one chassis to the other is provided.

17. A system according to claim 16 wherein said electrical connection means comprises a wire (100; 200) electrically connecting the one chassis to the other.

18. A system according to one of the preceding claims wherein the electronic device (13; 26) comprises at least one of a computer module or a computer peripheral module.

19. A system according to one of the preceding claims wherein the electronic device (13) comprises a tape drive means for a computer.

20. A system according to one of the preceding claims wherein the two windings (16, 17; 30, 31) of the common mode incutor means (15; 27) are wound in a same direction.

21. A system according to one of the preceding claims wherein said common mode inductor means (15; 27) comprises a toroidal core.

22. A system according to one of the preceding claims wherein the two windings (16, 17; 30, 31) of the common mode inductor means (15; 27) are wound such that differential mode interference currents cancel.

23. A system according to one of the preceding claims, further comprising:
the DC voltage output and DC voltage return of said power supply (23) comprises a first DC voltage output (39) and a first DC voltage return (40), and wherein a second DC voltage output (42) of said first polarity and a second DC voltage return (41) of said opposite second polarity are provided, the voltages at the first and second DC voltage outputs being different;
said DC voltage input and associated DC voltage return of said electronic device (26) comprising a first DC voltage input and a first DC voltage return, and wherein a second DC voltage input with a corresponding second DC voltage return are provided at the electronic device (26); and said sommon mode inductor means (27, 28) comprising a first common mode inductor (27) connecting the first DC voltage output (39) and the first DC voltage return (40) of the power supply (10) to the corresponding first DC voltage input and the first DC voltage return of the electronic device (13), and a second common mode inductor (28) whose first winding connects the second DC voltage output (42) and second DC voltage return (41) of the power supply (23) to the second DC voltage input and second DC voltage return of the electronic device (26), and wherein at the power supply (23) the first and second DC voltage returns (40, 41) are not connected to the chassis ground (38) at the location of the power supply (23) and are not connected together at the power supply, but at the electronic device (26) the first and second ground returns are connected together to the chassis ground (37) at the electronic device.

24. A system according to claim 23 wherein said first and second inductors (27, 28) having cores (29, 32) chosen sufficiently large to prevent saturation resulting from unequal currents (I1, I2) flowing toward the electronic device (26) from the power supply (10) as compared to return currents (I1r, I2r) flowing from the electronic device (26) to the power supply (23), such currents being different in view of a ground current (Ig) through the chassis ground.

25. A system according to claim 1 wherein the power supply (43) has first and second DC voltage outputs (55, 58) of a first polarity but different voltages and corresponding first and second DC voltage returns (56, 57) of an opposite second polarity, the electronic device having first and second DC voltage inputs of said first polarity but for said different voltages and corresponding first and second DC voltage returns of said opposite second polarity, said common mode inductor means (47) for suppressing electrostatic discharge noise having a common core (48) and fist, second, third and fourth windings (49, 50, 51, 52) thereon, the first winding (49) connecting the first voltage output (55) to the first voltage input, the second winding (52) connecting the second voltage output (58) to the second voltage input, the third winding (50) connecting the first electronic device return to the first power supply return (56), and the fourth winding (51) connecting the second electronic device return to the second power supply return (57), and means being provided for preventing a saturation of said core (48) as a result of DC supply and return currents flowing through said first through fourth windings.

26. A system according to claim 25 wherein the first and third windings (49, 50) comprise a first bifilar winding on the common core (48) and the second and fourth windings (51, 52) comprise a second bifilar winding on the common core (48).

27. A system according to claim 25 wherein the first and second windings (49, 52) comprise a first bifilar winding on the core (48) and the third and fourth windings (50, 51) comprise a second bifilar winding on the common core (48).

28. A system according to claim 25 wherein the first and second DC returns at the electronic device (46) are electrically connected at a location of said electronic device.

29. A system according to claim 25 wherein the first and second DC returns (56, 57) of the power supply (43) are electrically connected together at the location of the power supply (43).

30. A system according to claim 25 wherein the first and second returns (56, 57) are connected to chassis ground (54) at the location of the power supply (43) and the first and second returns at the electronic device are connected to chassis ground (53) through a resistance (Y) chosen so as to prevent saturation of the core (48) by minimizing ground currents (Ig) flowing from the electronic device (46) back to the power supply (43) so as to maintain a DC current balance such that a sum of supply currents (I1, I2) flowing in the first and second DC lines through corresponding windings of the core equals a sum of return currents (I1r, I2r) flowing in the first and second returns back to the power supply in corresponding windings of the core (48).

31. A system according to claim 25 wherein the common mode inductor means (47) is installed at the location of the power supply (43).

32. A system according to claim 25 wherein the returns (56, 57) at the power supply (43) are electrically connected together but are not connected to chassis ground (54) at the location of the power supply (43), and the returns at the electronic device (46) are connected to chassis ground (53) at the location of the electronic device (46).

33. A system according to claim 25 wherein a signal ground (SGND) is provided at the first and second return lines at the electronic device (46).

34. A system according to claim 25 wherein said means for preventing saturation comprises means for making a sum of supply currents (I1, I2) flowing in the first and second DC lines through corresponding windings of the core equal to a sum of return currents (I1r, I2r) flowing in the first and second returns back to the power supply in corresponding windings of the core (48).

Patentansprüche

1. System zum Unterdrücken von elektrostatischem Entladungsrauschen, mit:
einer elektronischen Vorrichtung (13, 26, 46) und einer Energieversorgung (10, 23, 43) für die elektronische Vorrichtung;
einer Chassiseinrichtung (1; 101, 102; 201, 202; 6, 301, 302) zum Aufnehmen der Energieversorgung (10, 23, 43) und der elektronischen Vorrichtung (13, 26, 46) und zum zur Verfügung Stellen eines Chassis-Erdungsanschlusses (21, 22; 37, 38);
wobei die Energieversorgung (10, 23, 43) an einem Teil der Chassiseinrichtung (1; 101; 202) angeordnet ist und einen Gleichspannungsausgang (9; 39) einer ersten Polarität und eine Gleichspannungsrückführung (8; 40) einer entgegengesetzten zweiten Polarität hat;
wobei die elektronische Vorrichtung (13, 26, 46) an einem weiteren Teil der Chassiseinrichtung (1; 102; 201) angeordnet ist und wenigstens einen Gleichspannungseingang (19; 55; 58) der ersten Polarität und wenigstens eine Gleichspannungsrückführung (20; 56; 57) der entgegengesetzten zweiten Polarität hat; und
Gleichtakt-Induktoreinrichtungen (15; 27; 47) zum Unterdrücken elektrostatischen Entladungsrauschens mit wenigstens einem gemeinsamen Kern (18; 29; 48); dadurch gekennzeichnet, daß die Gleichtakt-Induktoreinrichtung (15; 27, 28; 47) erste und zweite Wicklungen (16, 17; 30, 31) auf jedem gemeinsamen Kern (18; 29) hat, wobei die erste Wicklung (16; 30) den Gleichspannungsausgang der Energieversorgung mit dem Gleichspannungseingang der elektronischen Vorrichtung verbindet und die zweite Wicklung (17, 31) die Gleichspannungs rückführung der Energieversorgung mit der Gleichspannungsrückführung der elektronischen Vorrichtung verbindet, und daß das System weiterhin eine Einrichtung zum Verhindern von Sättigung

des gemeinsamen Kerns als ein Ergebnis eines Versorgungsgleichstromes (I), der von der Energieversorgung (10; 23) zu der elektronischen Vorrichtung (13; 26) durch die erste Wicklung (16; 30) fließt, und eines Rückführgleichstromes (Ir), der von der elektronischen Vorrichtung (13; 26) zurück zu der Energieversorgung (10; 23) durch die zweite Wicklung (17; 31) fließt, aufweist.

2. System nach Anspruch 1, bei dem die Vorrichtung zum Verhindern von Sättigung das Gestalten des gemeinsamen Kerns (18; 29) derart, daß jeglicher Unterschied zwischen den Größen des Versorgungsgleichstromes (I) und des Rückführgleichstromes (Ir) dessen Sättigung nicht verursacht, umfaßt.

3. System nach Anspruch 1, bei dem die Einrichtung zum Verhindern von Sättigung einer Einrichtung zum Herstellen der wesentlichen Gleichheit des Versorgungsstromes (I) und des Rückführstromes (Ir) aufweist, so daß ein relativ kleiner gemeinsamer Kern (18; 29) ohne Sättigung verwendet werden kann.

4. System nach Anspruch 3, bei dem die Einrichtung zum wesentlichen Gleichhalten der Ströme (I, Ir) eine Einrichtung (70; Y; 5) zum Verhindern, daß ein Masse-Rückführstrom von der Chassis-Masse (21, 22; 37, 38) von der elektronischen Vorrichtung (13; 26) zu der Energieversorgung (10; 23) fließt, so daß der gesamte Versorgungsstrom durch die zweite Wicklung (17; 31) als der Rückführstrom (Ir) fließt, aufweist.

5. System nach Anspruch 4, bei dem die Einrichtung (70; 5) zum Verhindern eines Masse-Rückführstromes das elektrische Nichtverbinden der Gleichspannungsrückführung entgegengesetzter Polarität der Energieversorgung mit der Chassis-Masse (22) an dem Ort der Energieversorgung (10) umfaßt.

6. System nach Anspruch 5, bei dem die Gleichspannungsrückführung der elektronischen Vorrichtung (13; 26) elektrisch mit der Chassis-Masse (21; 37) an dem Ort der elektronischen Vorrichtung verbunden ist.

7. System nach Anspruch 4, bei dem die Einrichtung (Y) zum Verhindern eines Masse-Rückführstromes das nicht direkte Verbinden der Gleichspannungsrückführung der elektronischen Vorrichtung (13; 26) mit der Chassis-Masse (21; 37) an dem Ort der elektronischen Vorrichtung umfaßt.

8. System nach Anspruch 4, bei dem die Einrichtung (70, Y; 5) zum Verhindern eines Masse-Rückführstromes umfaßt, das die Gleichspannungsrückführungen entweder an der Energieversorgung (10; 23) oder der elektronischen Vorrichtung (13; 26) nicht direkt mit der Chassis-Masse verbunden sind.

9. System nach Anspruch 4, bei dem die Einrichtung zum Verhindern eines Masse-Rückführstromes das Vorsehen eines Widerstandes (Y) zwischen der Gleichspannungsrückführung (20) an der elektronischen Vorrichtung (13; 26) und Chassis-Masse (21; 37) an dem Ort der elektronischen Vorrichtung umfaßt, wobei die Gleichspannungsrückführung an der Energieversorgung (10; 23) mit der Chassis-Masse (22; 38) an dem Ort der Energieversorgung verbunden ist, und bei dem eine Größe des Widerstandes (Y) derart gewählt wird, daß im wesentlichen verhindert wird, daß ein Masse-Strom (Ig) fließt, was zu einer Differenz des Versorgungsstromes (I) und des Rückführstromes (Ir) führen würde, die in den ersten und zweiten Wicklungen (16, 17; 30, 31) fließen, was die Sättigung des gemeinsamen Kerns (18; 29) verursachen würde.

10. System nach Anspruch 1, bei dem elektronische Vorrichtung (13; 26) einen entkoppelnden Kondensator (X) zwischen dem Gleichspannungseingang (19) und der Gleichspannungsrückführung (20) hat.

11. System nach Anspruch 1, bei dem an der elektronischen Vorrichtung (13; 26) die Gleichspannungsrückführung (20) mit einer Signal-Masse (SGND) verbunden ist und die Gleichspannungsrückführung (20) zu dem Ort der Energieversorgung (10; 23) getrieben wird.

12. System nach Anspruch 1, bei dem die Signal-Masse (SGND) sich auf einer gedruckten Leiterkarte befindet, die Teil der elektronischen Vorrichtung (13; 26) ist.

13. System nach Anspruch 1, bei dem die Gleichspannungsrückführung (20) mit der Chassis-Masse (21; 37) an der elektronischen Vorrichtung (13; 26) verbunden ist, jedoch nicht mit der Chassis-Masse (22; 38) an dem Ort der Energieversorgung (10; 23) verbunden ist, um so einen Ausgangsgleichstrom (I) aus der Energieversorgung zur elektronischen Vorrichtung im wesentlichen gleich einem Rückführstrom (Ir) von der elektronischen Vorrichtung zu der Energieversorgung bei der Rückführung zu machen, so daß im wesentlichen keine Masseströme (Ig) durch die Chassiseinrichtung (1; 101, 102; 201, 202; 6;

301, 302) von der Chassis-Masse (21) der elektronischen Vorrichtung zu der Energieversorgung fließen, was somit beim Verhindern einer Sättigung des Kerns (18; 29) der Gleichtakt-Induktoreinrichtung (15; 27) hilft, die durch ungleiche Gleichströme in den beiden Wicklungen (16, 17; 30, 31) der Induktoreinrichtung verursacht wird.

14. System nach Anspruch 1, bei dem die Chassiseinrichtung ein gemeinsames Chassis (1) aufweist, in dem sowohl die Energieversorgung (10; 23) als auch die elektronische Vorrichtung (13; 26) angeordnet ist.

15. System nach Anspruch 1, bei dem die Chassiseinrichtung zwei getrennte Chassis (101, 102; 201, 202) aufweist, eines (101; 202) für die Energieversorgung (10; 23) und eines (102; 201) für die elektronische Vorrichtung (13; 26).

16. System nach Anspruch 15, bei dem eine elektrische Verbindereinrichtung (100; 200), um zu erlauben, daß Masse-Ströme von einem Chassis zu dem anderen fließen, vorgesehen ist.

17. System nach Anspruch 16, bei dem die elektrische Verbindereinrichtung einen Draht (100; 200) aufweist, der das eine Chassis elektrisch mit dem anderen verbindet.

18. System nach einem der vorangehenden Ansprüche, bei dem die elektronische Vorrichtung (13; 26) wenigstens entweder ein Computermodul oder ein Computer-Peripheriemodul aufweist.

19. System nach einem der vorangehenden Ansprüche, bei dem die elektronische Vorrichtung (13) eine Bandtreibereinrichtung für einen Computer aufweist.

20. System nach einem der vorangehenden Ansprüche, bei dem die beiden Wicklungen (16, 17; 30, 31) der Gleichtakt-Induktoreinrichtung (15; 27) in einer gleichen Richtung gewickelt sind.

21. System nach einem der vorangehenden Ansprüche, bei dem die Gleichtakt-Induktoreinrichtung (15; 27) einen toroidalen Kern aufweist.

22. System nach einem der vorangehenden Ansprüche, bei dem die beiden Wicklungen (16, 17; 30, 31) der Gleichtakt-Induktoreinrichtung (15; 27) derart gewickelt sind, daß sich Interferenzströme im differentiellen Modus auslöschen.

23. System nach einem der vorangehenden Ansprüche, das weiterhin aufweist:

Der Gleichspannungsausgang und die Gleichspannungsrückführung der Energieversorgung (23) weisen einen ersten Gleichspannungsausgang (39) und eine zweite Gleichspannungsrückführung (40) auf, und wobei ein zweiter Gleichspannungsausgang (42) der ersten Polarität und eine zweite Gleichspannungsrückführung (41) der entgegengesetzten zweiten Polarität vorgesehen sind, wobei die Spannungen am ersten und zweiten Gleichspannungsausgang verschieden sind;
wobei der Gleichspannungseingang und die zugeordnete Gleichspannungsrückführung der elektronischen Vorrichtung (26) einen ersten Gleichspannungseingang und eine erste Gleichspannungsrückführung aufweisen und wobei ein zweiter Gleichspannungseingang mit einer entsprechenden zweiten Gleichspannungsrückführung an der elektronischen Vorrichtung (26) vorgesehen sind; und die Gleichtakt-Induktoreinrichtung (27, 28) einen ersten Gleichtakt-Induktor (27), der den ersten Gleichspannungsausgang (39) und die erste Gleichspannungsrückführung (40) der Energieversorgung (10) mit dem entsprechenden ersten Gleichspannungseingang und der ersten Gleichspannungsrückführung der elektronischen Vorrichtung (13) verbindet, und einen zweiten Gleichtakt-Induktor (28), dessen erste Wicklung den zweiten Gleichspannungsausgang (42) und die zweite Gleichspannungsrückführung (41) der Energieversorgung (23) mit dem zweiten Gleichspannungseingang und der zweiten Gleichspannungsrückführung der elektronischen Vorrichtung (26) verbindet, aufweist und wobei an der Energieversorgung (23) die erste und zweite Gleichspannungsrückführung (40, 41) nicht mit der Chassis-Masse (38) an dem Ort der Energieversorgung (23) verbunden sind und an der Energieversorgung nicht zusammengeschaltet sind, jedoch an der elektronischen Vorrichtung (26) die erste und zweite Masse-Rückführung zusammen an die Chassis-Masse (37) an der elektronischen Vorrichtung geschaltet sind.

24. System nach Anspruch 23, bei dem die ersten und zweiten Induktoren (27, 28) Kerne (29, 32) haben, die ausreichend groß gewählt sind, um Sättigung zu verhindern, die aus ungleichen Strömen (I1, I2) herrühren, die in Richtung auf die elektronische Vorrichtung (26) von der Energieversorgung (10) fließen, im Vergleich mit Rückführströmen (I1r, I2r), die von der elektronischen Vorrichtung (26) zu der Energieversorgung (23) fließen, wobei solche Ströme im Hinblick auf einen Masse-Strom (Ig) durch die Chassis-Masse unterschiedlich sind.

25. System nach Anspruch 1, bei dem die Energieversorgung (43) erste und zweite Gleichspannungsausgänge (55, 58) einer ersten Polarität hat, jedoch unterschiedliche Spannungen, und entsprechende erste und zweite Gleichspannungsrückführungen (56, 57) einer entgegengesetzten zweiten Polarität, wobei die elektronische Vorrichtung erste und zweite Gleichspannungseingänge der ersten Polarität, aber für die unterschiedlichen Spannungen, hat, und entsprechende erste und zweite Gleichspannungsrückführungen der entgegengesetzten zweiten Polarität, wobei die Gleichtakt-Induktoreinrichtung (47) zum Unterdrücken elektrostatischen Entladungsrauschens einen gemeinsamen Kern (48) und erste, zweite, dritte und vierte Wicklungen (49, 50, 51, 52) darauf hat, wobei die erste Wicklung (49) den ersten Spannungsausgang (55) mit dem ersten Spannungseingang verbindet, die zweite Wicklung (52) den zweiten Spannungsausgang (58) mit dem zweiten Spannungseingang verbindet, die dritte Wicklung (50) die erste Rückführung der elektronischen Vorrichtung mit der ersten Rückführung (56) der Energieversorgung verbindet und die vierte Wicklung (51) die zweite Rückführung der elektronischen Vorrichtung mit der zweiten Rückführung (57) der Energieversorgung verbindet, und bei der Einrichtungen vorgesehen sind, um eine Sättigung des Kerns (48) als ein Ergebnis dessen zu verhindern, daß Versorgungs- und Rückführgleichströme durch die ersten bis vierten Wicklungen fließen.

26. System nach Anspruch 25, bei dem die erste und dritte Wicklung (49, 50) eine erste bifilare Wicklung auf dem gemeinsamen Kern (48) aufweisen und die zweite und vierte Wicklung (51, 52) eine zweite bifilare Wicklung auf dem gemeinsamen Kern (48) aufweisen.

27. System nach Anspruch 25, bei dem die erste und zweite Wicklung (49, 52) eine erste bifilare Wicklung auf dem Kern (48) aufweisen und die dritte und vierte Wicklung (50, 51) eine zweite bifilare Wicklung auf dem gemeinsamen Kern (48) aufweisen.

28. System nach Anspruch 25, bei dem die erste und zweite Gleichstromrückführung in der elektronischen Vorrichtung (46) elektrisch mit einem Ort der elektrischen Vorrichtung verbunden sind.

29. System nach Anspruch 25, bei dem die erste und zweite Gleichstromrückführung (56, 57) der Energieversorgung (43) an dem Ort der Energieversorgung (43) miteinander elektrisch verbunden sind.

30. System nach Anspruch 25, bei dem die erste und zweite Rückführung (56, 57) mit der Chassis-Masse (54) an dem Ort der Energieversorgung (43) verbunden sind und die erste und zweite Rückführung an der elektronischen Vorrichtung mit der Chassis-Masse (53) über einen Widerstand (Y) verbunden sind, der so gewählt wird, daß er die Sättigung des Kernes (48) verhindert, indem Masse-Ströme (Ig), die von der elektronischen Vorrichtung (46) zurück zu der Energieversorgung (43) fließen, minimiert werden, um somit eine Gieichstrombalance aufrecht zu erhalten, derart, daß eine Summe von Versorgungsströmen (I1, I2), die in den ersten und zweiten Gleichstromleitungen durch entsprechende Wicklungen der Kerne fließen, gleich einer Summe von Rückführungsströmen (I1r, I2r) ist, die in den ersten und zweiten Rückführungen zurück zu der Energieversorgung in entsprechenden Wicklungen des Kerns (48) fließen.

31. System nach Anspruch 25, bei dem die Gleichtakt-Induktoreinrichtung (47) an dem Ort der Energieversorgung (43) eingerichtet ist.

32. System nach Anspruch 25, bei dem die Rückführungen (56) an der Energieversorgung (43) elektrisch miteinander verbunden sind, jedoch an dem Ort der Energieversorgung (43) nicht mit der Chassis-Masse (54) verbunden sind, und die Rückführungen an der elektronischen Vorrichtung (46) an dem Ort der elektronischen Vorrichtung (46) mit der Chassis-Masse (53) verbunden sind.

33. System nach Anspruch 25, bei dem eine Signal-Masse (SGND) an den ersten und zweiten Rückführleitungen an der elektronischen Vorrichtung (46) vorgesehen ist.

34. System nach Anspruch 25, bei dem die Einrichtung zum Verhindern von Sättigung eine Einrichtung zum Einstellen einer Summe von Versorgungsströmen (I1, I2), die in den ersten und zweiten Gleichstromleitungen durch entsprechende Wicklungen des Kerns fließen, gleich einer Summe von Rückführungsströmen (I1r, I2r), die in den ersten und zweiten Rückführungen zurück zu der Energieversorgung in entsprechenden Wicklungen des Kerns (48) fließen, aufweist.

Revendications

1. Système d'élimination du bruit de décharge électrostatique comprenant:
un dispositif électronique (13, 26, 46) et une alimentation (10, 23, 43) pour ce dispositif électro-

nique,
un moyen formant châssis (1; 101, 102; 201, 202; 6; 301, 302) destiné à recevoir l'alimentation (10, 23, 43) et le dispositif électronique (13, 26, 46) et fournir une masse de châssis (21, 22; 37, 38),
l'alimentation (10, 23, 43) étant située dans une partie du moyen formant châssis (1; 101, 202) et ayant une sortie en tension continue (9; 39) ayant une première polarité et un retour en tension continue (8; 40) d'une deuxième polarité opposée à la première,
le dispositif électronique (13, 26, 46) étant situé dans une autre partie du moyen formant châssis (1; 102; 201) et ayant au moins une entrée en tension continue (19; 55; 58) de la première polarité et au moins un retour en tension continue (20; 56; 57) de la deuxième polarité opposée à la première, et
un moyen d'inductance de mode commun (15; 27; 47) pour l'élimination du bruit de décharge électrostatique, ayant au moins un noyau commun (18; 29; 48),
caractérisé par le fait que le moyen d'inductance de mode commun (15; 27, 28; 47) a un premier et un deuxième enroulement (16, 17; 30, 31) sur chaque noyau commun (18; 29), le premier enroulement (16; 30) reliant la sortie en tension continue de l'alimentation à l'entrée en tension continue du dispositif électronique et le deuxième enroulement (17; 31) reliant le retour en tension continue de l'alimentation au retour en tension continue du dispositif électronique, et que le système comprend en outre des moyens empêchant une saturation du noyau commun résultant d'un courant continu d'alimentation (I) allant de l'alimentation (10; 23) au dispositif électronique (13; 26) par le premier enroulement (16; 30) et d'un courant continu de retour (Ir) revenant du dispositif électronique (13; 26) à l'alimentation (10; 23) par le deuxième enroulement (17; 31).

2. Système selon la revendication 1, dans lequel les moyens empêchant la saturation comprennent la conception du noyau commun (18; 29) de façon qu'une différence entre les intensités du courant continu d'alimentation (I) et du courant continu de retour (Ir) ne produise pas de saturation de celui-ci.

3. Système selon la revendication 1, dans lequel les moyens empêchant la saturation comprennent des moyens rendant le courant d'alimentation (I) et le courant de retour (Ir) sensiblement égaux afin qu'un noyau commun relativement petit (18; 29) puisse être utilisé sans saturation.

4. Système selon la revendication 3, dans lequel les moyens rendant les courants (I, Ir) sensiblement égaux comprennent des moyens (70, Y; 5) empêchant un courant de retour par la masse d'aller par la masse de châssis (21, 22; 37, 38) depuis le dispositif électronique (13; 26) à l'alimentation (10; 23) afin que tout le courant d'alimentation revienne par le deuxième enroulement (17; 31) comme courant de retour (Ir).

5. Système selon la revendication 4, dans lequel les moyens (70; 5) empêchant un courant de retour par la masse comprennent la non-liaison électrique de ce retour en tension continue de polarité opposée de l'alimentation à la masse de châssis (22) à l'endroit de l'alimentation (10).

6. Système selon la revendication 5, dans lequel le retour en tension continue au dispositif électronique (13; 26) est relié électriquement à la masse de châssis (21; 37) à l'endroit du dispositif électronique.

7. Système selon la revendication 4, dans lequel les moyens (Y) empêchant un courant de retour par la masse comprennent la non-liaison directe à la masse de châssis (21; 37) du retour en courant continu du dispositif électronique (13; 26) à l'endroit de celui-ci.

8. Système selon la revendication 4, dans lequel les moyens (70; Y; 5) empêchant un courant de retour par la masse comprennent la non-liaison directe à la masse de châssis des retours en courant continu soit à l'alimentation (10; 23), soit au dispositif électronique (13; 26).

9. Système selon la revendication 4, dans lequel les moyens empêchant un courant de retour par la masse comprennent le montage d'une résistance (Y) entre le retour en courant continu (20) au dispositif électronique (13; 26) et la masse de châssis (21; 37) à l'endroit du dispositif électronique, le retour en courant continu à l'alimentation (10; 23) étant connecté à la masse de châssis (22; 38) à l'endroit de l'alimentation, et dans lequel la valeur de la résistance (Y) est choisie de façon à pratiquement empêcher la circulation d'un courant à la masse (Ig) qui créerait une différence entre le courant d'alimentation (I) et le courant de retour (Ir) passant dans les premier et deuxième enroulements (16, 17; 30, 31) qui provoquerait la saturation du noyau commun (18; 29).

10. Système selon la revendication 1, dans lequel le dispositif électronique (13; 26) a une capacité de découplage (X) entre l'entrée en tension continue (19) et le retour en tension continue (20).

11. Système selon la revendication 1, dans lequel, au

dispositif électronique (13; 26), le retour en courant continu (20) est connecté à une masse de signaux (SGND) et le retour en courant continu (20) est flottant à l'endroit de l'alimentation (10; 23).

12. Système selon la revendication 1, dans lequel la masse de signaux (SGND) est située sur un circuit imprimé qui fait partie du dispositif électronique (13; 26).

13. Système selon la revendication 1, dans lequel le retour en courant continu (20) est connecté à la masse de châssis (21; 37) au dispositif électronique (13; 26) mais n'est pas connecté à la masse de châssis (22; 38) à l'endroit de l'alimentation (10; 13) afin de rendre le courant continu de sortie (I) allant de l'alimentation au dispositif électronique sensiblement égal au courant de retour (Ir) allant du dispositif électronique à l'alimentation dans ce retour afin qu'il ne circule pratiquement pas de courants à la masse (Ig) dans le moyen formant châssis (1; 101, 102; 201, 202; 6; 301, 302) de la masse de châssis (21) du dispositif électronique à l'alimentation, pour aider à empêcher une saturation du noyau (18; 29) du moyen d'inductance de mode commun (15; 27) due à des courants continus inégaux dans les deux enroulements (16, 17; 30, 31) du moyen d'inductance.

14. Système selon la revendication 1, dans lequel le moyen formant châssis comprend un châssis commun (1) dans lequel sont montés à la fois l'alimentation (10; 23) et le dispositif électronique (13; 26).

15. Système selon la revendication 1, dans lequel le moyen formant châssis comprend deux châssis séparés (101, 102; 201, 202), l'un (101; 202) pour l'alimentation (10; 23) et l'autre (102; 201) pour le dispositif électronique (13; 26).

16. Système selon la revendication 15, dans lequel est prévu un moyen de connexion électrique (100; 200) permettant la circulation de courants à la masse d'un châssis à l'autre.

17. Système selon la revendication 16, dans lequel le moyen de connexion électrique comprend un fil (100; 200) reliant électriquement un châssis à l'autre.

18. Système selon l'une des revendications précédentes, dans lequel le dispositif électronique (13; 26) comprend au moins un module d'ordinateur ou un module périphérique d'ordinateur.

19. Système selon l'une des revendications précédentes, dans lequel le dispositif électronique (13) comprend un moyen d'entraînement de bande pour un ordinateur.

20. Système selon l'une des revendications précédentes, dans lequel les deux enroulements (16, 17; 30, 31) du moyen d'inductance de mode commun (15; 27) sont enroulés dans le même sens.

21. Système selon l'une des revendications précédentes, dans lequel le moyen d'inductance de mode commun (15; 27) comprend un noyau torique.

22. Système selon l'une des revendications précédentes, dans lequel les deux enroulements (16. 17; 30, 31) du moyen d'inductance de mode commun (15; 27) sont enroulés de façon que les courants parasites en mode différentiel s'annulent.

23. Système selon l'une des revendications précédentes, dans lequel, en outre :
la sortie en tension continue et le retour en tension continue de l'alimentation (23) comprennent une première sortie en tension continue (39) et un premier retour en tension continue (40) et il est prévu une deuxième sortie en tension continue (42) de la première polarité et un deuxième retour en tension continue (41) de la deuxième polarité opposée à la première, les tensions aux première et deuxième sorties en tension continue étant différentes,
l'"entrée en tension continue et le retour en tension continue associé du dispositif électronique (26) comprennent une première entrée en tension continue et un premier retour en tension continue, et une deuxième entrée en tension continue et un deuxième retour en tension continue correspondant sont prévus au dispositif électronique (26), et le moyen d'inductance de mode commun (27, 28) comprend une première inductance de mode commun (27) qui relie la première sortie en tension continue (39) et le premier retour en tension continue (40) de l'alimentation (10) à la première entrée en tension continue correspondante et au premier retour en tension continue du dispositif électronique (13), et une deuxième inductance de mode commun (28) dont le premier enroulement relie la deuxième sortie en tension continue (42) et le deuxième retour en tension continue (41) de l'alimentation (23) à la deuxième entrée en tension continue et au deuxième retour en tension continue du dispositif électronique (26), et à l'alimentation (23), les premier et deuxième retours en tension continue (40, 41) ne sont pas connectés à la masse de châssis

(38) à l'endroit de l'alimentation (23) ni connectés ensemble à l'alimentation, mais au dispcsitif électronique (26), les premier et deuxième retours par la masse sont connectés ensemble à la masse de châssis (37) au dispositif électronique.

24. Système selon la revendication 23, dans lequel les première et deuxième inductances (27, 28) ont des noyaux (29, 32) suffisamment grands pour empêcher une saturation résultant de courants inégaux (I1, 12) allant de l'alimentation (10) vers le dispositif électronique (26) comparativement aux courants de retour (I1r, I2r) allant du dispositif électronique (26) à l'alimentation (23), ces courants étant différents en raison de la circulation d'un courant à la masse (Ig) dans la masse de châssis.

25. Système selon la revendication 1, dans lequel l'alimentation (43) a une première et une deuxième sortie en tension continue (55, 58) d'une première polarité mais de tensions différentes et un premier et un deuxième retour en tension continue correspondants (56, 57) d'une deuxième polarité opposée à la première, le dispositif électronique a une première et une deuxième entrée en tension continue de la première polarité mais pour les tensions différentes et un premier et un deuxième retour en tension continue de la deuxième polarité opposée à la première, le moyen d'inductance de mode commun (47) destiné à éliminer le bruit de décharge électrostatique a un noyau commun (48) et un premier, un deuxième, un troisième et un quatrième enroulement (49, 50, 51, 52) portés par celui-ci, le oremier enroulement (49) reliant la première sortie en tension (55) à la première entrée en tension, le deuxième enroulement (52) reliant la deuxième sortie en tension (58) à la deuxième entrée en tension, le troisième enroulement (50) reliant le premier retour du dispositif électronique au premier retour (56) de l'alimentation, et le quatrième enroulement (51) reliant le deuxième retour du dispositif électronique au deuxième retour (57) de l'alimentation, et il est prévu des moyens empêchant une saturation du noyau (48) due aux courants continus d'alimentation et de retour circulant dans les premier à quatrième enroulements.

26. Système selon la revendication 25, dans lequel les premier et troisième enroulements (49, 50) comprennent un premier enroulement bifilaire placé sur la noyau commun (48) et les deuxième et quatrième enroulements (51, 52) comprennent un deuxième enroulement bifilaire placé sur le noyau commun (48).

27. Système selon la revendication 25, dans lequel les premier et deuxième enroulements (49, 52) comprennent un premier enroulement bifilaire placé sur le noyau commun (48) et les troisième et quatrième enroulements (50, 51) comprennent un deuxième enroulement bifilaire placé sur le noyau commun (48).

28. Système selon la revendication 25, dans lequel les premier et deuxième retours en courant continu au dispositif électronique (46) sont reliés électriquement à un endroit de celui-ci.

29. Système selon la revendication 25, dans lequel les premier et deuxième retours en courant continu (56, 57) de l'alimentation (43) sont reliés électriquement ensemble à l'endroit de celle-ci.

30. Système selon la revendication 25, dans lequel les premier et deuxième retours (56, 57) sont connectés à la masse de châssis (54) à l'endroit de l'alimentation (43) et les premier et deuxième retours au dispositif électronique sont reliés à la masse de châssis (53) par l'intermédiaire d'une résistance (Y) choisie de façon à empêcher la saturation du noyau (48) en réduisant au minimum les courants à la masse (Ig) revenant du dispositif électronique (46) à l'alimentation (43) afin de maintenir un équilibre des courants continus tel que la somme des courants d'alimentation (I1, 12) circulant dans les première et deuxième lignes à courant continu en passant par les enroulements correspondants du noyau soit égale à la somme des courants de retour (I1r, I2r) revenant par les premier et deuxième retours à l'alimentation en passant par les enroulements correspondants du noyau (48).

31. Système selon la revendication 25, dans lequel le moyen d'inductance de mode commun (47) est monté à l'endroit de l'alimentation (43).

32. Système selon la revendication 25, dans lequel les retours (56, 57) à l'alimentation (43) sont reliés électriquement ensemble mais ne sont pas connectés à la masse de châssis (54) à l'endroit de l'alimentation (43), et les retours au dispositif électronique (46) sont connectés à la masse de châssis (53) à l'endroit du dispositif électronique (46).

33. Système selon la revendication 25, dans lequel une masse de signaux (SGND) est prévue aux première et deuxième lignes de retour au dispositif électronique (46).

34. Système selon la revendication 25, dans lequel les moyens empêchant la saturation comprennent des moyens rendant la somme des courants d'alimentation (I1, 12) circulant dans les première et deuxième lignes à courant continu en passant par les enroulements correspondants du noyau égale à la somme des courants de retour (I1r, I2r) revenant par les premier et deuxième retours à l'alimentation en passant par les enroulements correspondants du noyau (48).

Figure 1

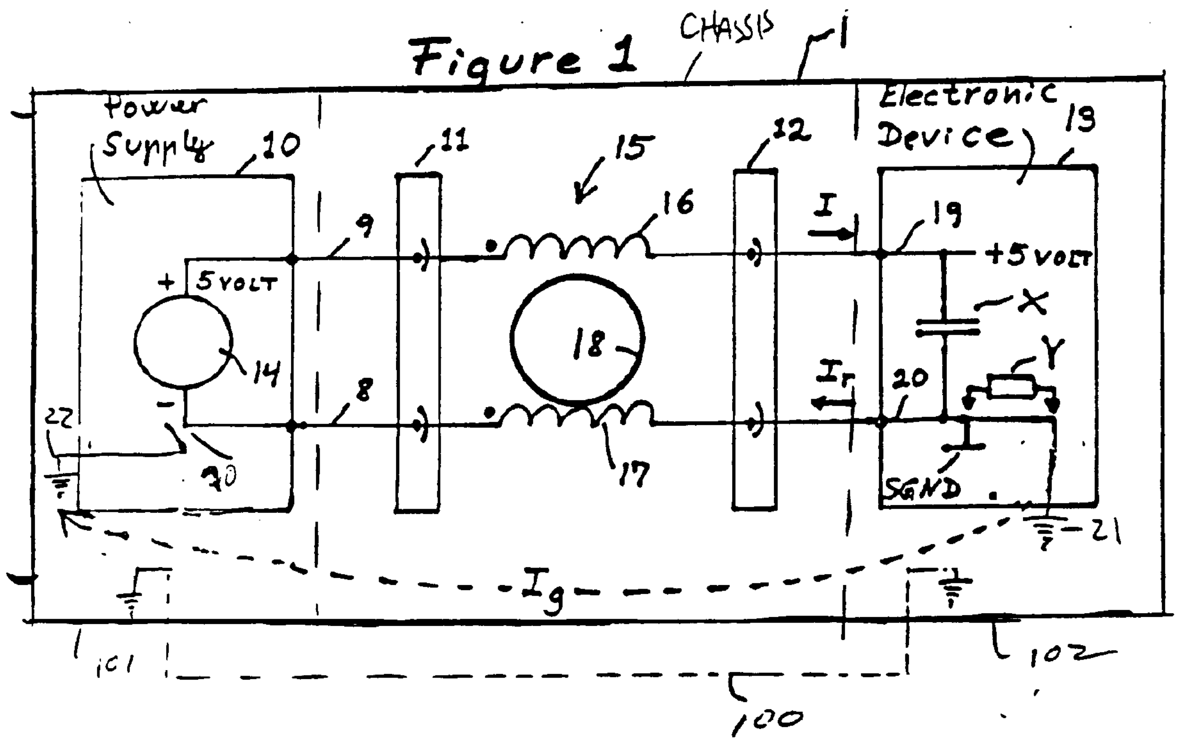
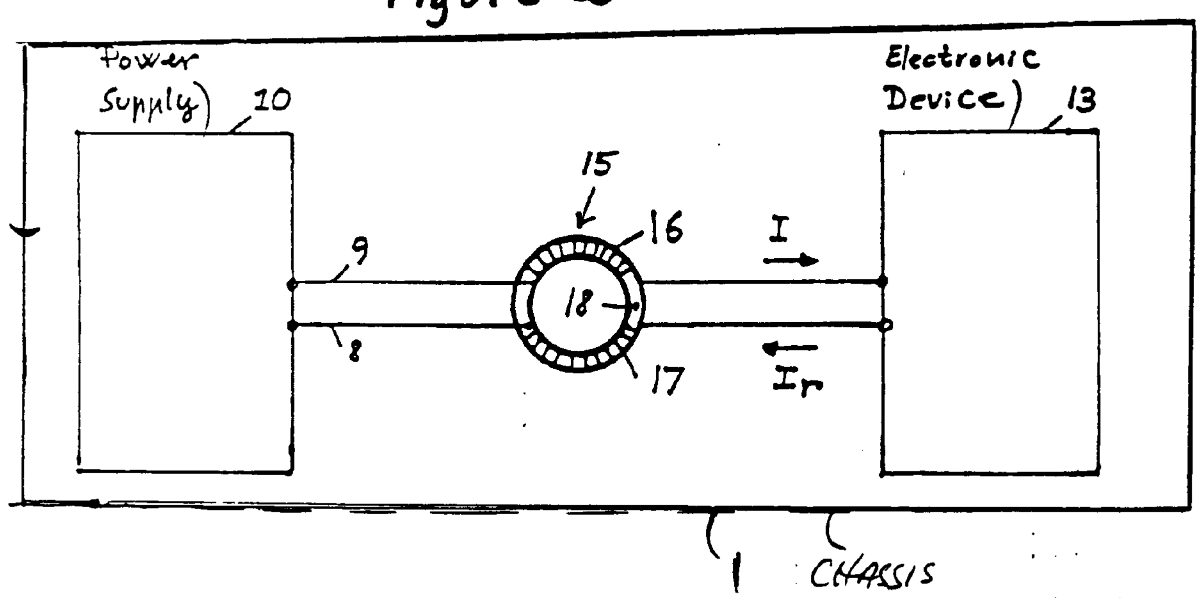


Figure 2



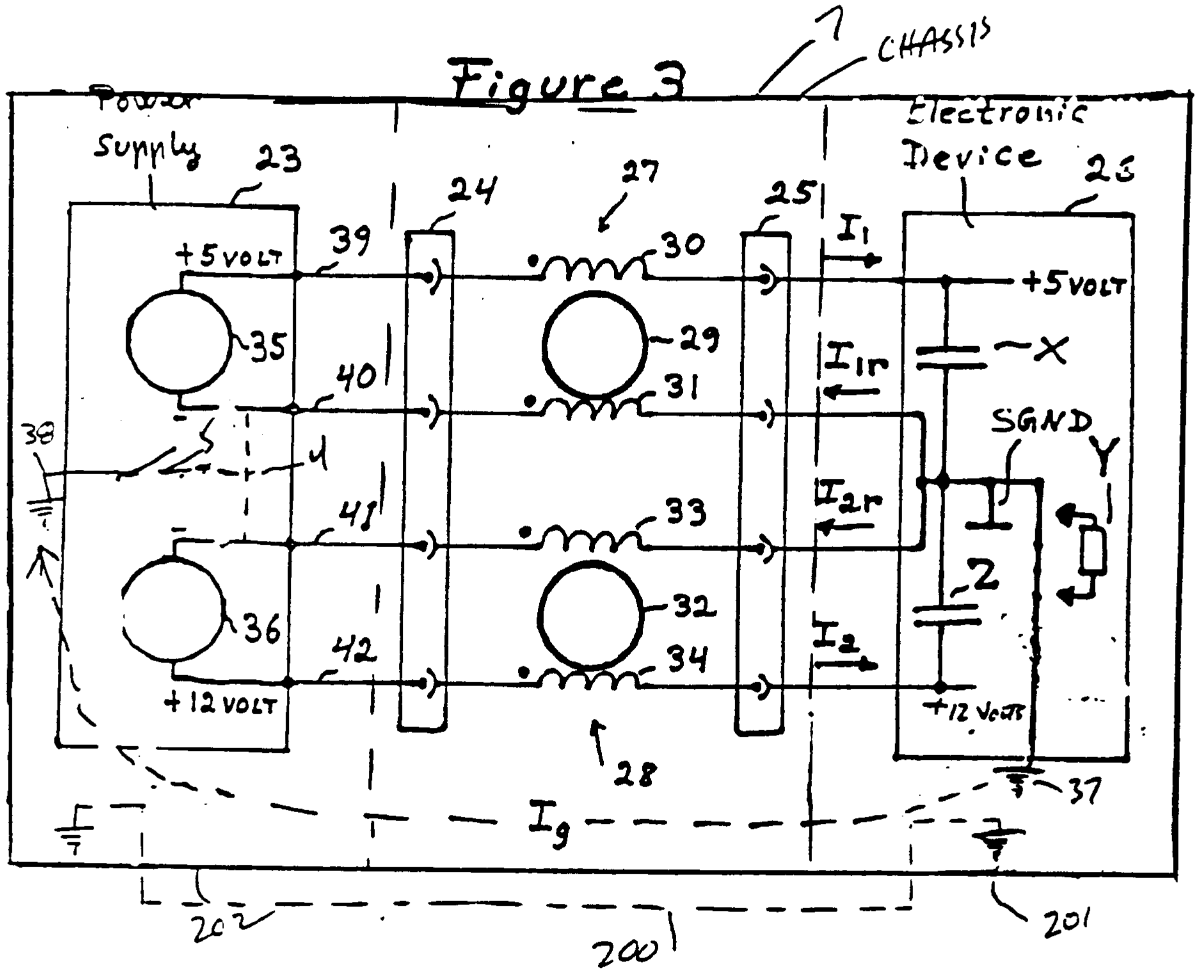


Figure 3

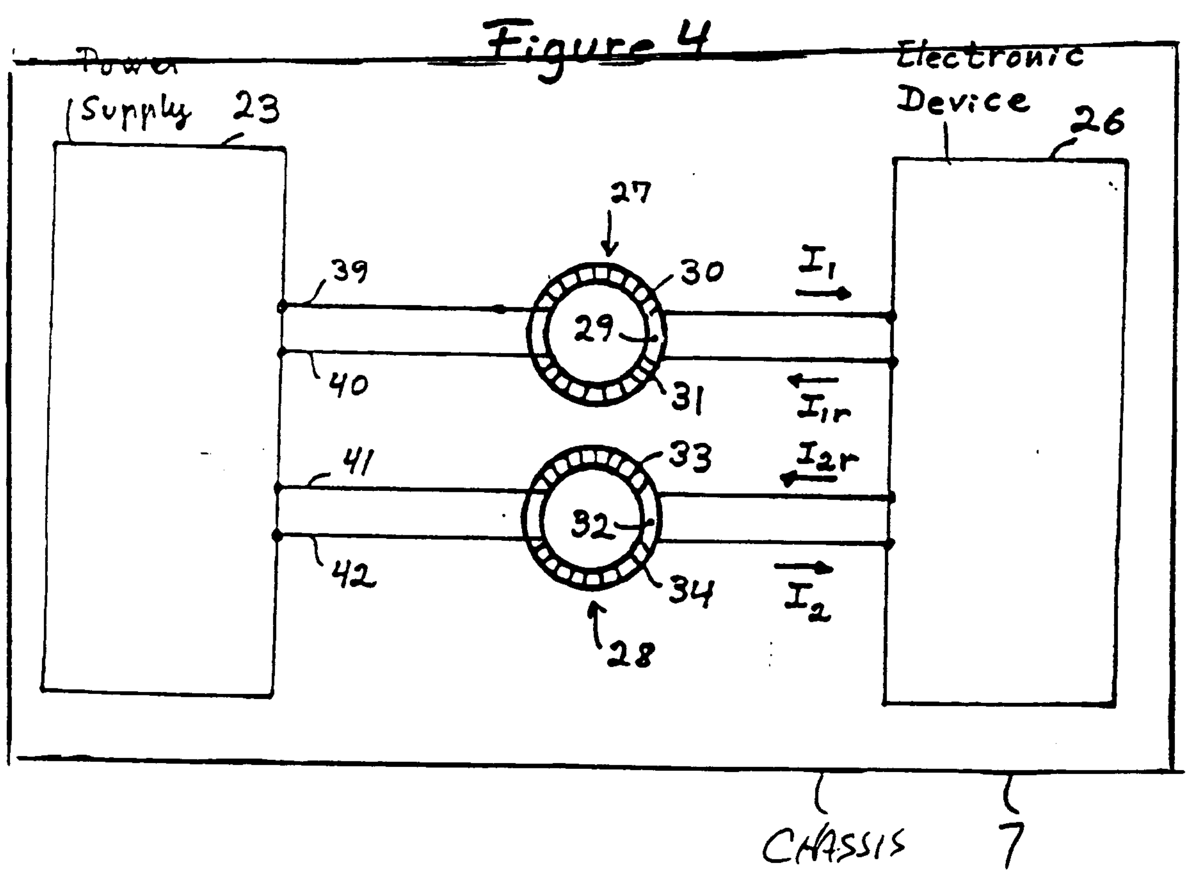


Figure 4

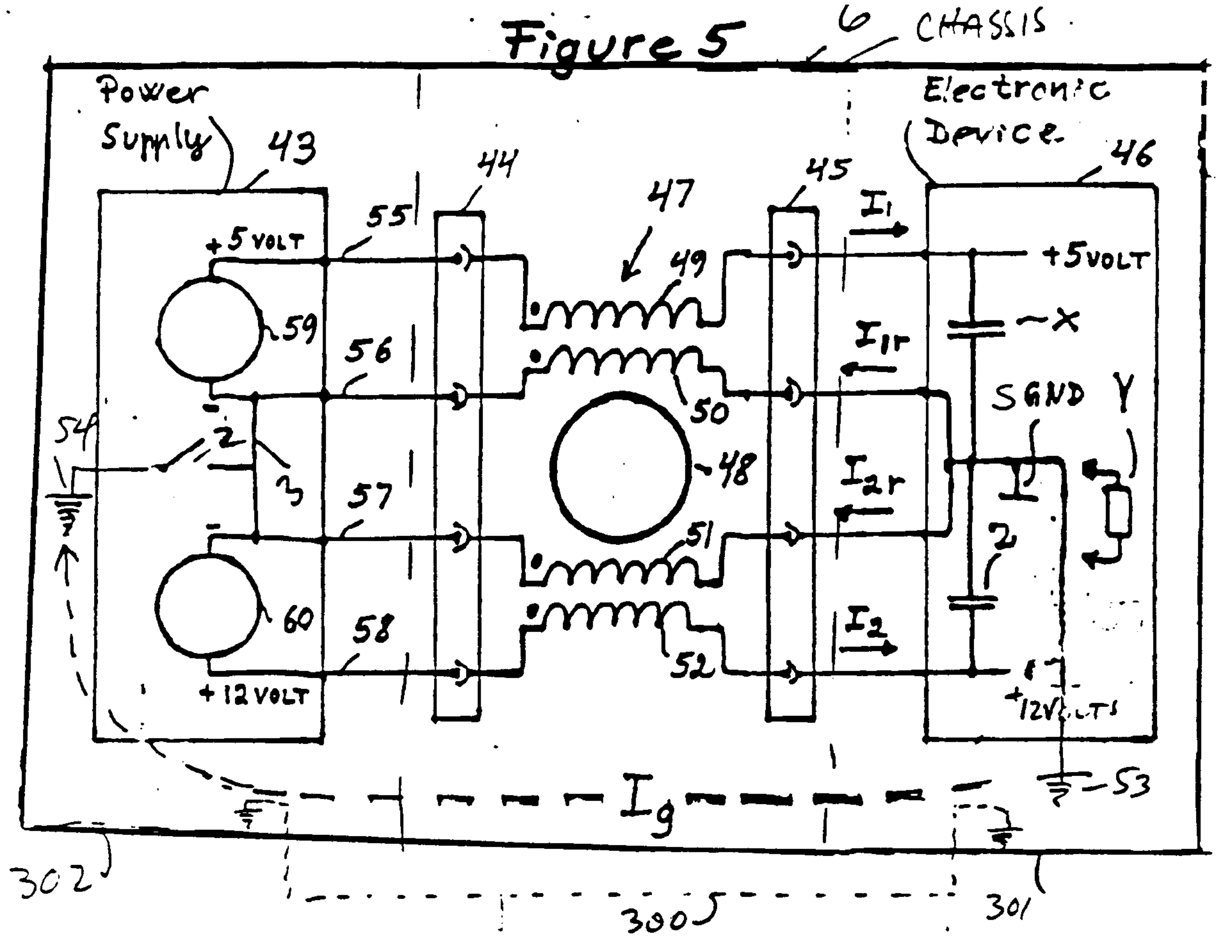


Figure 5
6 CHASSIS
Power Supply 43
Electronic Device 46
44
45
47
55
56
57
58
+5 VOLT
+12 VOLT
59
60
54
2
3
49
50
48
51
52
I1
I1r
I2r
I2
+5VOLT
~X
SGND
Y
Z
+12VOLTS
53
Ig
302
300
301

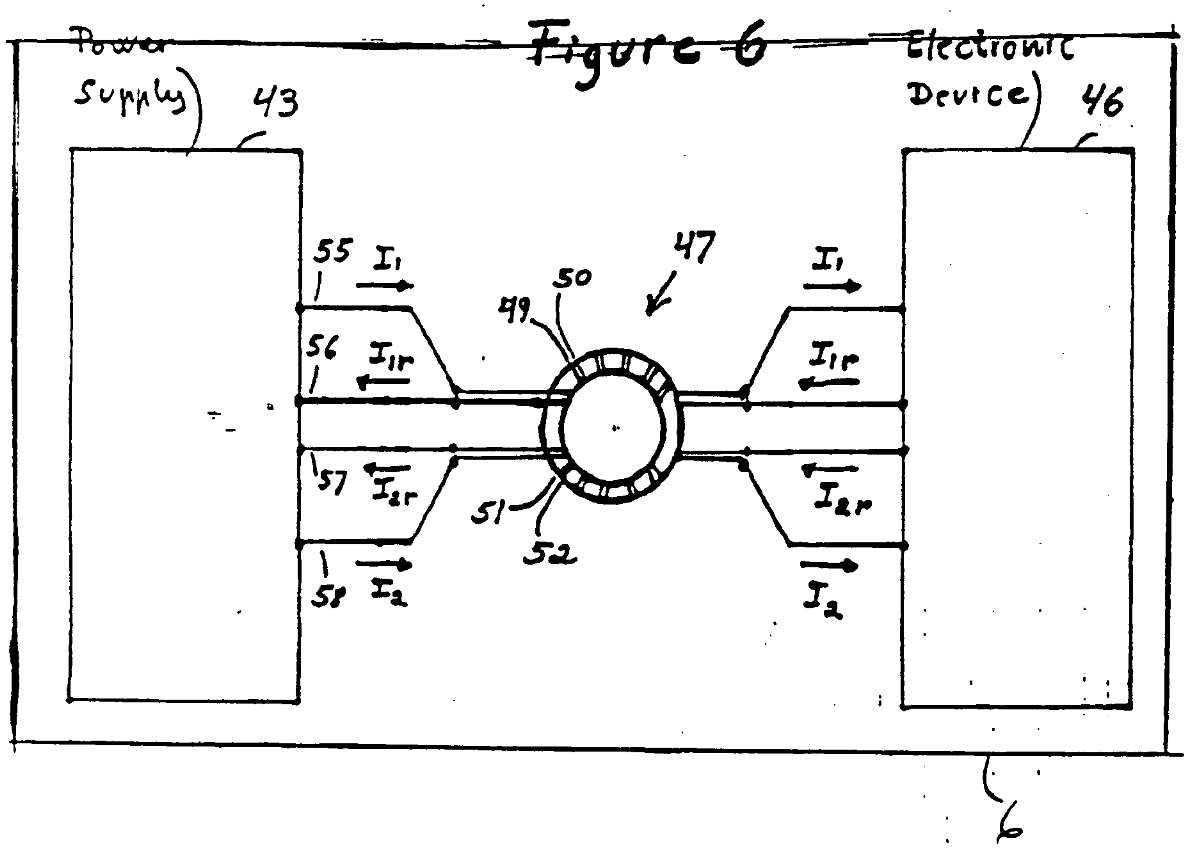


Figure 6
Power Supply 43
Electronic Device 46
47
55
56
57
58
I1
I1r
I2r
I2
49
50
51
52
6

Figure 7

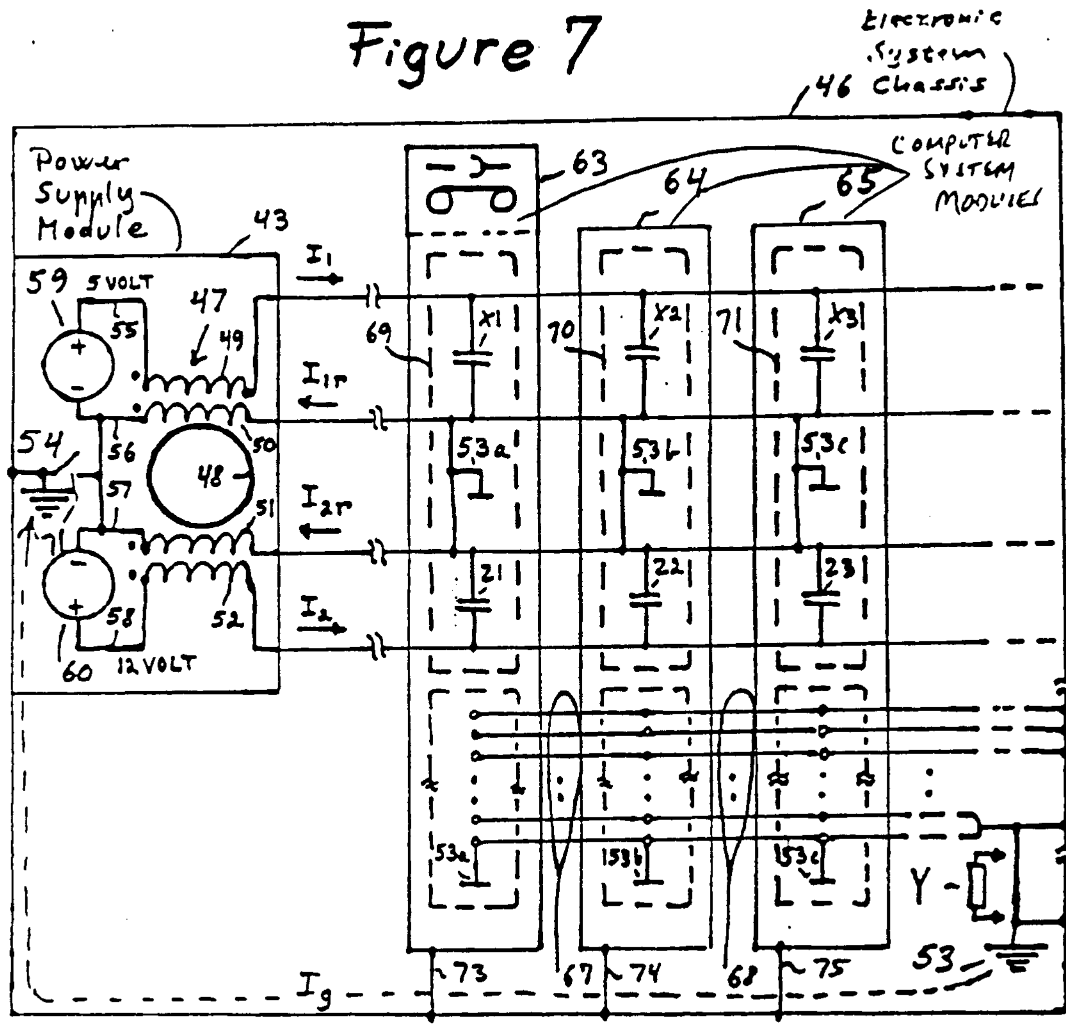


FIGURE 8